



Instructional Edutainment Media "Number Game" Based on Mobile Technology to Improve Mathematical Conceptual Understanding

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ABSTRAK

Integrasi teknologi dalam pembelajaran menjadi tantangan pendidikan era digital saat ini, sehingga perlu inovasi agar proses konstruktivitas kognitif siswa lebih optimal. Penelitian pengembangan ini bertujuan untuk menghasilkan media edutainment berupa video game "Number Game" berbasis teknologi mobile yang berkualitas. Jenis penelitian ini yaitu pengembangan dengan menggunakan model ADDIE. Metode pengumpulan data menggunakan kuesioner dan tes. Game mobile diimplementasikan kepada siswa kelas VII SMP yang terdiri dari 34 siswa. Instrumen penelitian terdiri dari lembar validasi media dan materi, angket praktikalitas guru dan siswa, dan instrumen tes kemampuan pemahaman konsep. Hasil penelitian menunjukkan bahwa media edutainment "Number Game" yang dikembangkan valid dengan rerata skor validasi media yaitu 4,49 dengan klasifikasi sangat baik. Rerata skor validasi materi yaitu 4,17 dengan klasifikasi baik. Game "Number Game" yang dikembangkan praktis dengan rerata skor angket respon guru yaitu 3,75 dengan klasifikasi baik, rerata skor angket respon siswa yaitu 3,35 dengan klasifikasi baik, dan rerata persentase keterlaksanaan pembelajaran yaitu 93,51% dengan kategori sangat baik. Game "Number Game" yang dikembangkan efektif ditinjau dari kemampuan pemahaman konsep siswa dengan persentase ketuntasan belajar mencapai 67,64 dengan klasifikasi efektif. Disimpulkan game edukasi layak dan efektif digunakan dalam pembelajaran.

ABSTRAK

Integrating technology into learning is a challenge for education in the current digital era, so innovation is needed to make students' cognitive, constructive processes more optimal. This development research aims to produce edutainment media in the form of quality mobile technology-based "Number Game" video games. This type of research is developed using the ADDIE model. Methods of data collection using questionnaires and tests. The mobile game was implemented for VII graders of junior high school consisting of 34 students. The research instruments comprised media and material validation sheets, teacher and student practicality questionnaires, and conceptual understanding ability test instruments. The results showed that the "Number Game" edutainment media developed was valid with an average media validation score of 4.49, with a very good classification. The mean material validation score is 4.17, with a good classification. The "Number Game" game developed is practical, with an average teacher response questionnaire score of 3.75 with a good classification, an average student response questionnaire score is 3.35 with a good classification, and an average percentage of learning implementation is 93.51% with a very good category. The "Number Game" game effectively understood students' concepts, with a learning completeness percentage of 67.64 with an effective classification. It is concluded that educational games are feasible and effective in learning.

1. INTRODUCTION

Mathematics is a branch of science that forms the basis for developing other branches of science (Awalia et al., 2019; Syahrir et al., 2020). Mathematics learning generally contains material and concepts

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regarding the structure of numbers, formulas, and structures related to shapes and spaces, as well as their magnitude and changes (Alfiyah et al., 2021; Dwianjani & Candiasa, 2018). In practice, learning mathematics is not only focused on memorization but invites students to think critically to understand the concept of the material correctly (Darmayanti et al., 2018; Ningsih & Hayati, 2020). Mathematics learning is carried out to develop students' thinking skills, especially in terms of understanding mathematical concepts as a whole, developing mathematical reasoning abilities, developing problem-solving abilities, and developing mathematical communication skills (Atmaja et al., 2021; Nugroho & Warmi, 2022; Setyadi & Wardani, 2020). One of the aspects developed in learning mathematics in the 21st century is the ability to understand conceptual mathematics. Conceptual understanding is a student's ability to understand, absorb, and apply mathematical concepts in everyday life (Purba et al., 2023; Sengkey et al., 2023). Students need mathematical and conceptual abilities to solve various problems that exist in everyday life, especially those related to mathematics (Giriansyah et al., 2023; Rinowati et al., 2022).

Understanding concepts is important to improve because it is mathematics's main goal and function (Febriyani et al., 2022; Nurdin et al., 2019). Understanding mathematical concepts can be an important basis for solving mathematical and everyday problems (Fajar et al., 2019). The reality shows that students' mathematical conceptual abilities are still relatively low. It is evidenced by the results of observations and interviews conducted with teachers and students of SMP Negeri 3 Kota Sungai Penuh. The results of observations and interviews show that many students still have math scores below the minimum completeness criteria. The low results of students' mathematics learning are because students still think that mathematics is a very difficult and boring subject, so in the implementation of learning, students prefer to remain silent and are not active in teaching and learning activities. The results of these observations were then supported by the results of the PISA survey in 2015, which also showed that the performance of Indonesian students in mathematics was still relatively low and was ranked 63 out of 69 countries evaluated (Hidayat et al., 2020; Khairunnisa et al., 2022). These data indicate that students' understanding of concepts, especially in Indonesia, still needs to improve. If left unchecked, these problems will certainly have an impact on reducing the quality of education and not achieving the goals of learning mathematics.

One effort that can be done to overcome these problems is to utilize the use of technology-based learning media. One type of technology-based learning media that can be developed is innovative learning media with a video game-based edutainment approach. Video game-based learning is an important topic in education in today's digital era because our digital society grows by adapting to multitasking in a hypermedia world, and video games benefit learning mathematics (Beaumont et al., 2021; Febriyani et al., 2020). The development of video games as learning media in Indonesia has considerable potential, seeing that it is very rare to find learning media in the form of games on Playstore, which is a provider of game download services on Android (Dieris-Hirche et al., 2020; Harris & Isyanti, 2021). Game learning media has many advantages over other learning media, such as influencing cognitive function, activating metacognitive and training self-evaluative abilities, and increasing students' intrinsic motivation (Braad et al., 2020; Ravenilia et al., 2020). Learning media in video games is a learning media that is packaged based on games (Einstein et al., 2022; Handayani et al., 2022). Whereas we all know that video games are one of the games that are very popular with children, so the use of this media will be able to attract students' interest in learning. One of the game media that can be used in the mathematics learning process is media with an edutainment approach. An edutainment approach is a suitable approach to integrating technology into education. It is because the edutainment media approach can facilitate the learning process and make learning activities student-centered (Dewi & Sintaro, 2019; Rahmadhani & Hidayati, 2020). In media with an edutainment approach, there are several features such as computer games, boards and videos, movies, music, websites, multimedia, and so on (Pratama et al., 2020; Suri et al., 2023). Several previous studies have revealed that the response of teachers and students in developing Android-based learning media is very practical for use in the learning process at school (Suri et al., 2023). Other studies reveal that edutainment media effectively accompanies students learning from home (Pratama et al., 2020). The results of further research reveal that edutainment-based learning multimedia in Integrated IPS subjects is feasible and practical to support the learning process and make it more enjoyable (Rahmadhani & Hidayati, 2020). Based on some of the results of these studies, it can be said that edutainment-based learning media is very effective in the learning process. In previous research, no study specifically discusses the development of mobile technology-based "number game" instructional edutainment media to improve conceptual understanding of mathematics. So this research is focused on this study to produce quality edutainment media in the form of a video game, "Number Game," based on mobile technology.

2. METHOD

This research belongs to the type of development research which was developed using the ADDIE model. The ADDIE model comprises five research stages: analysis, design, development, implementation, and evaluation. The five phases or stages in the ADDIE model can be seen in Figure 1.

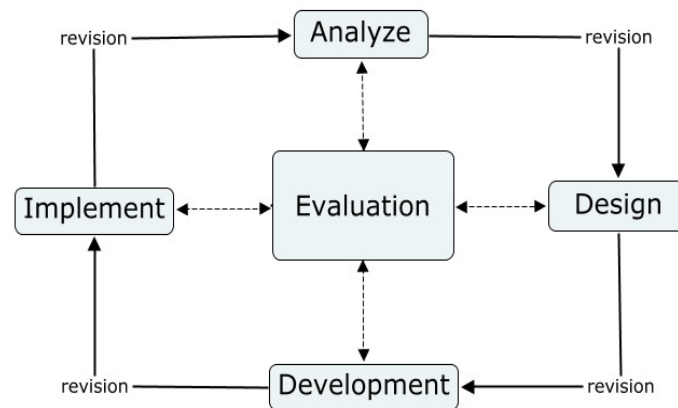


Figure 1. ADDIE Development Model

The analysis phase in this study was carried out through the process of needs analysis, curriculum analysis, analysis of student characteristics, analysis of resources, and analysis of work plans. Analysis was done using a need assessment instrument, documents, and observation sheets. After obtaining the media analysis results, it is designed based on the needs of teachers and students. The design process consists of the process of making instructional media designs which includes outlining the content of learning media, validating media, design validation, and instrument validation used in research which is an activity process to assess learning media that has been designed and whether the media created is rationally valid or invalid, and creating items for carrying out tests of ability to understand concepts and instruments measuring students' interest in learning mathematics.

The media that has been designed is then developed based on the design results. The development stage includes activities to develop and modify learning media and then product testing by conducting trials. There are two special stages in formative evaluation, including individual trials (one-to-one trials) on three students and one teacher and small group trials (small group trials) conducted on nine students with different abilities (high, medium, and low). The fourth stage is the product implementation stage. The products that have been tested are applied in real situations with actual teaching to 34 students and then conducted a post-test to determine the potential effect on students' mathematical conceptual abilities. After the implementation stage of the research was carried out, it was followed by the evaluation stage after obtaining input from the previous four stages, both formative and summative. Data collection in the study was carried out using the method of observation, interviews, and questionnaires, with research instruments in the form of material validation sheets, media validation sheets, and teacher and student practicality questionnaires. These conceptual understanding test instruments had gone through a validation process by instrument experts and known the validity and reliability of the instruments. The grid for each instrument can be seen in Table 1.

Table 1. Research Instruments

Formula	Research Instruments	Indicator
validity	Media validation sheet	Content quality, Learning design alignment, Feedback and Adaptation, Affective, Face-to-face design, Interactivity, Accessibility, Usability, and Standard Adjustment
Practicality	Material validation sheet	Content Quality, Purpose, and Instructional Quality
	Teacher practicality questionnaire Student practicality questionnaire	Attractiveness, Ease of Use, and Content Quality Attractiveness and Ease of Use
effectiveness	Concept comprehension test questions	1. Students can solve problems related to the order of several integers and fractions (ordinary, mixed, decimal, percent)

Formula	Research Instruments	Indicator
		2. Solve problems related to integer and fraction arithmetic operations
		3. Solving problems related to large integers as positive integer powers

The research data were analyzed by determining the quality category of the developed learning media. The steps used to meet the quality criteria for the product being developed are data in the form of scores of experts/practitioners and respondents obtained through the research instrument added up. The actual total score obtained is converted into qualitative data on a scale of five (Likert). The data analysis is divided into 3: analysis of the validity of learning media, analysis of the practicality of using learning media, and analysis of the effectiveness of learning media developed.

3. RESULT AND DISCUSSION

Results

This development research used the ADDIE development model with five research stages. The results of each development are as follows: the first development stage is the analysis stage. The analysis process involves needs, curriculum, and student analyses. A needs analysis was carried out by conducting unstructured interviews with students as research subjects and teachers who teach in research implementation classes. Based on the interview results, it is known that Android games are being loved by junior high school students, where it is found that students in class tend to spend time during their recess hours playing the latest released Android games both online and offline. The types of games played by students can be seen in [Table 2](#).

Table 2. Types of games often played by junior high school students

Game name	Game Type
Sword of Xolan	Platform
Mobile Legend	MoBA
Super Mario Bross	Platform
BadLand	Platform
Manuganu	Platform
Free Fire	Battle Royal
Clash of Clans (COC)	Strategy Game (RPG)
Harvest Moon	RPG
Leo's Fortune	Platform
Super Dangerous Dungeons	Platform
Limbo	Platform
Dan the Man	Platform
Arena of Valor	MoBa
Player Unknown Battle Ground (PUBG)	Battle Royal

Based on the data in [Table 1](#), it can be seen that the types of games favored by junior high school students are platform-type games. In addition, the results of interviews and field surveys show that in order to design an educational game that is appropriate to field conditions, an attractive game is needed with a colorful appearance and has a modern interface, can be played offline or online, and can be run with an Android device with minimum specifications. The game developed must have a mobile and PC version so that during research, students who do not have adequate Android can use a PC device to play it, and it must have simple and easy-to-understand navigation in use.

The second analysis is curriculum analysis which shows that in the subject matter of numbers, the obstacle is the need for supporting media for teaching. Researchers examined the syllabus, competencies, and materials for Numbers material, so the researchers developed the "Number Game" game based on the 2013 curriculum, which also requires students to learn independently. The third analysis is the analysis of students, which shows that the research subjects are students of SMP Negeri 3 Kota Sungai Lilin class VII B with an age range of 11-12 years. According to the teacher who taught mathematics for class VII B, students had a very high level of curiosity offset by the need to play, so class VII B was chosen as the research subject. The results of interviews with research subjects found that they always play Android games daily. The average student spends 2-3 hours daily playing Android games. The second development

stage is the learning media design stage which is based on the game process flow in the game, which is applied to games with the Construct 2 program. The interface is designed to be more attractive to answer the needs of students who want games that have an attractive appearance. After the flowchart is made, the next step is to make Edutainment learning media in the form of the "Number Game" game, as shown in Figure 2.



Figure 2. The Main View of the "Number Game" Game

Each level uses a platform game technique, where the ability to understand students' concepts is carried out by providing activities to choose examples and not examples, an introductory scientific approach is used to explain how the scientific approach is applied in games, the display of Knowing Integer Material at this level the game will direct the user to find the concept of numbers and the display of digging up the information presented material that needs to be discussed as shown in Figure 3.



Figure 3. An Example of a Layout Display for Learning Materials

Media assessment was carried out by two experts in mathematics education and learning media experts who analyzed the media based on the aspects determined and given in the form of a media validation questionnaire. The following are the results of media evaluation by media experts. Complete data can be seen in Table 3.

Table 3. Data Validation Results by Media Experts

No.	Aspect	Average per aspect	Criteria
1	Content quality	4.00	Valid
2.	Alignment of learning design	4.12	Valid
3.	Feedback and Adaptation	4.75	Very Valid
4.	Affective	4.75	Very Valid
5.	Face-to-face design	4.62	Very Valid
6.	Interactivity	4.62	Very Valid
7.	Accessibility	4.60	Very Valid
8.	usability	4.00	Valid
9.	Standard Adjustment	5.00	Very Valid
Overall average		4.49	Very Valid

The data in Table 2 shows that the learning media experts' validation results obtained a total average score of 4.49. So the results of the assessment are included in the category $\bar{x} > 4,2$, so the edutainment game "Number Game" is included in the Very Valid category. 2 experts carried out an assessment of the material used in the media by analyzing the media based on the aspects determined and given in the form of a material validation questionnaire. The following are the results of the material assessment by material experts in Table 4.

Table 4. Results of Validation by Material Experts

No	Aspect	First Expert	Second Expert	Average per aspect
1	Content Quality and Purpose	4.187	4.375	4.281
2.	Instructional Quality	4.000	4.142	4.071
Overall Average				4.176
Criteria				Valid

Based on Table 3, the results of the validation of learning material experts for the feasibility of learning materials in the "Number Game" edutainment game obtained a total score of 4.17. So the assessment results are included in the "valid" category in terms of the material used. The third stage is development, carried out through a one-to-one trial process. Researchers carried out individual trials with three students with different levels of ability to assess the edutainment games being developed and one math teacher. In some of the student responses, the researcher concluded that there were several suggestions for improvement in writing that needed to be clarified and sentences that needed to be corrected. There were still bugs while playing games and small group trials. The small group trial samples selected by researchers were 12 students with low, medium, and high ability criteria. The fourth stage is the implementation stage, where at this stage, the products that have been tested are applied in real situations with actual teaching involving research subjects. After implementation, students are given post-test questions and practical questionnaires. The results of the practicality analysis can be seen in Table 5.

Table 5. The Results of the Practicality Assessment of Student Learning Media

Interval Score	Criteria	Student Response	
		Frequency	Percentage (%)
$\bar{x} > 4,2$	Very good	1	2.941
$3,4 \leq \bar{x} \leq 4,2$	Good	14	41.176
$2,3 \leq \bar{x} < 3,4$	Good Enough	19	55.882
$1,8 \leq \bar{x} < 2,3$	Less Good	0	0.000
$\bar{x} \leq 4,2$	Not good	0	0.000
Rata-rata		3,3508	

The data in Table 5 shows that the average practicality score of students is 3.35, with a qualitatively good classification ($3,4 \leq \bar{x} \leq 4,2$). Besides that, looking at the percentage of student responses, 55.882% of students rated the game's practicality as quite good, 42.17% said it was good, and 2.94% had a very good practical response. The teacher's response also stated that the average score of interesting aspects was 4.25, with a qualitative classification of very good ($\bar{x} \geq 4,2$). The average score for ease of use is 3.75, with a qualitative classification of good ($3,4 \leq \bar{x} \leq 4,2$). The average content quality score is 4.62, with a quantitative classification of very good ($\bar{x} \geq 4,2$). The results of students' conceptual understanding ability tests can be seen from the number of students with grades that meet the school's minimum completeness criteria in Table 6.

Table 6. The results of the test of the ability to understand the concept

Interval Score	Student Frequency	Percentage	Criteria
$80 < t \leq 100$	23	67.6%	Effective
$60 < t \leq 80$	8	33.4%	Less effective
$40 < t \leq 60$	3	8.8 %	Ineffective

The data in Table 6 shows that the percentage of passing grades for students meeting the minimum standard of completeness criteria is 67.64%, with 23 students graduating and 11 failing. It has fulfilled 2/3 of the students passing the minimum completeness criteria, and besides that, the passing percentage is at $80\% < t \leq 100\%$ with an effective classification.

Discussion

The validity of product development shows that learning media are developed based on theories used as guidelines in formulating and compiling learning media (Hasanah et al., 2019). In this case, the guideline used to see the validity of the media is the LORI (Learning Object Review Instrument) indicator. The main objective of LORI is to balance the validity of the assessment with the efficiency of the product evaluation process. Based on the data obtained from the media and material validation questionnaire, it can be concluded that the product developed is valid and feasible to use because it is by the indicators evaluating the validity of a media. It shows that the product will be said to be valid if the product developed is based on a strong theoretical rationale and there is internal consistency between the components of the product being developed. Furthermore, the validity of game media development will also affect its use in the learning process (Lv et al., 2022; Xiong et al., 2022).

The analysis of teacher and student responses indicates that the smartphone-based Number Game edutainment learning media is oriented toward understanding students' mathematical concepts and fulfilling practical criteria because they fulfill all the proposed practical indicators. These results indicate that the practicality of mobile games is because all respondents have actively used mobile devices so that the characteristics of playing while learning are fulfilled (Braad et al., 2020; Handicap & Setyaningrum, 2021; Ravenilia et al., 2020). Good edutainment game development needs to pay attention to the characteristics of a game, characteristics are inherently interdependent for each and all have the same overall goal, which is to motivate and excite users (gamers) (Einstein et al., 2022; Handayani et al., 2022). Well-developed games will increase learning enthusiasm and motivation so students can study independently (Kayan & Aydın, 2020). Increasing student enthusiasm for learning is inseparable from designing game designs that use displays with bright colors and the use of characters that junior high school users like (Pratama et al., 2020; Suri et al., 2023), where the learning interest variable can contribute to the practicality and addition of students' mathematics learning achievement.

The achievement of the passing criteria for students studying mathematics after using the "Number Game" game indicates that games can produce effective learning. It is the function of learning media that can significantly reduce the difficulty of understanding learning material. The application of game media will improve students' problem-solving abilities by developing strategies and organizing elements in anticipating goals (Dewi & Sintaro, 2019; Rahmadhani & Hidayati, 2020). The "Number Game" game is designed to make the user active in playing by using interactive buttons and with activities that increase understanding through seeing examples and non-examples and with the risk of repeating the game if the user chooses the wrong example (Omolu, 2018; Zirawaga et al., 2017). Such learning activities will increase student activity to understand more deeply so that the development of students' conceptual understanding abilities is more concentrated (Cheung & Ng, 2021). The results obtained in this study are in line with the results of previous research, which also revealed that the responses of teachers and students in developing Android-based learning media were very practical for use in the learning process at school (Suri et al., 2023). Other studies reveal that edutainment media effectively accompanies students learning from home (Pratama et al., 2020). The results of further research reveal that edutainment-based learning multimedia in Integrated social science subjects is feasible and practical to support the learning process and make it more enjoyable (Rahmadhani & Hidayati, 2020). So based on some of the results of these studies, it can be said that edutainment-based learning media is very effectively used in the learning process.

4. CONCLUSION

Based on the results of the development of android-based edutainment game media oriented towards understanding students' mathematical concepts, the final product is the "Number Game" game which has quality as an assessment carried out by experts indicating that the "Number Game" edutainment media developed is valid and meets good criteria.

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